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STUDY ON ARSENIC LEVEL IN GROUND WATER OF DELHI USING HYDRIDE GENERATOR ACCESSORY COUPLED WITH ATOMIC ABSORPTION SPECTROPHOTOMETER

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ABSTRACT

Surveillance of drinking water is essentially a health measure intended to protect the public from water borne diseases. Hydride generator accessory coupled with atomic absorption spectrophotometer was used to analyze arsenic level in 49 ground water samples collected from different areas of Delhi. Arsenic level in ground water samples was in the range of 0.0170 to 0.100 ppm (Mean-0.0431, Standard Deviation-0.0136, Std. error of Mean-0.00194) with minimum concentration at Raney Well No. 7 (0.0170 ppm) and maximum at Kotla Mubarak Pur (0.100 ppm). Arsenic containing sediments and percolation of chemicals into soil as the result of dumping of garbage rich in chemicals into open landfills could be the possible source of arsenic in ground water of Delhi. Extensive survey and continuous monitoring is required to be made to assess the magnitude of problem and earlier intervention.

KEY WORDS

Arsenic, ground water, hydride generator accessory, atomic absorption spectrophotometer.

INTRODUCTION

Arsenic is a ubiquitous, nonessential, bio-accumulative element known since 387 B.C. Its compounds have been used as medicine, insecticides, wood preservatives, dye and industrial chemicals (1). Toxic exposure of human beings to arsenic and its compounds may occur through air, water, seafood, tobacco smoking, beverages medicinal preparations and industrial chemicals (2). Worldwide, the main reason for a chronic human intoxication with arsenic is the intake of contaminated drinking water (3).

Arsenic and its compounds are naturally present in low concentration at places with high geothermal activities (2). The current drinking water quality guideline by WHO for arsenic is 0.01 ppm (4). Long term exposure to elevated level of arsenic in water may cause serious health hazards like rhinopharyngitis, pulmonary insufficiency, interstitial fibrosis, hyperkeratosis of palm and soles, melanosis, noncirrhotic portal fibrosis, myocardial damage with ECG changes, hypertension, peripheral vascular disease, sensorimotor polyneuropathy, retrobulbar neuritis, encephalopathy, bilateral optic atrophy, deafness, bowens disease, haemangioen-dothelioma of liver, leukemia, malignancy of stomach, urinary bladder, oesophagous, kidney, bone and lungs.(2, 5-15)

In India, natural exposure of man to arsenic through drinking water of wells, hand pumps and springs in Chandigarh and its surrounding areas was first highlighted in 1976 (16-17). Arsenic contamination of ground water in West Bengal was first reported in 1983, but the relationship of dermatological manifestation to arsenic in water of tube wells of West Bengal was established by 1984 (18). However, the magnitude of the problem remains undetermined till 1995. So far more than 3,00,000 people of 9 districts of West Bengal have developed arsenicosis due to consumption of arsenic contaminated drinking water (19). Toxic level of arsenic in ground water has also been reported from villages of Rajnandgaon district of Madhya Pradesh (19) and some areas of Bihar (20). 1n

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1997, people of 34 districts of Bangaldesh were reported to be drinking arsenic contaminated water (6). In the combined area of West Bengal and Bangladesh about 150 million people are at risk from arsenic contaminated ground water (21). Arsenic contamination of well water in Minnetosa and Taiwan has caused signs and symptoms of arsenic toxicity (22, 23). Similar results have been reported from Northern Mexico, Nova Scotia Canada, Finland, Alaska and China (24-28).

In Delhi, drinking water supply is not from single source. Sixty eight percent of the population is getting supply from water of Yamuna River. Ground water sources like tube wells, hand pumps and borings are the other sources. As far as quality is concerned there is regular monitoring of physical parameters only. Suspended impurities such as metals are not monitored. Most of the times ground water is directly used. The present study was aimed to analyze arsenic level in ground water sources of Delhi and to look for the possible source of contamination.

MATERIALS AND METHODS

Sampling

Water samples were collected by using plastic bottles of capacity of one litre. All bottles used were washed with 1% nitric acid (BDH, E.Merck(India) Ltd, Mumbai (Maharashtra), India). Before collecting the sample, bottles were rinsed three-five times with the water to be filled. After filling with water few drops of concentrated nitric acid were added to the water samples for preservation till analysis. Total 49 ground water samples involving tube wells, hand pumps and borings were collected from different areas of Delhi as shown in Table 1.

Preparation of Samples

Samples were filtered using 0.45 μm Whattman filter paper. Initial filter was used for the rinsing of volumetric flask.

Standard

All the solutions were prepared with distil (deionized) water. Arsenic stock solution containing 980 μgm per ml (980 ppm) (Sigma Chemical Company, St. Louis, USA) was used for preparing the standards.

METHODS

Arsenic in water was determined according to the study of C.J. Wyatt *et al.* (15). Air -Acetylene flame type of Atomic Absorption Spectrophotometer (AAS 4127) along with Hydride Generator Accessory both of ECIL Company were used for analysis of arsenic in water. Hollow Cathode Lamp of Arsenic was used (10 mA, wavelength 193.7). Nitrogen was used as inert gas. Sodium Borohydride (CDH Lab. Reagents, Mumbai-New Delhi, India) and Hydrochloric acid -HCl Min.35% (E. Merck (India) Ltd., Mumbai, Maharashtra, (India) were used for the hydride formation. Arsenic V was reduced to As III with a reduction with Potassium Iodide (Qualigens Fine Chemicals, Mumbai (Maharashtra), India) prior to the formation of the hydride as the sensitivity of instrument for detection of As III was higher 70-80% in comparison to As V (10-20%). Results were analysed using SPSS and Barlett's Chi Square test.

RESULTS

Arsenic level in 49 ground water samples collected from different areas of Delhi is shown in table 1. Arsenic level detected was in the range of 0.0170 ppm to 0.100 ppm (Mean-0.0431, Standard Deviation-0.0136, Std. error of Mean-0.00194). The minimum value was found in the ground water sample of Raney well no.7 (0.017 ppm) and maximum value in the ground water sample of Kotla Mubarak Pur (0.100 ppm). Arsenic level in tube wells of Bawana was found to be in the range of 0.022-0.044 ppm (Mean-0.034, Standard Deviation-0.011, Std. error of Mean-0.0065). In all the areas arsenic level in ground water is more than permissible limit of WHO (1993)(4). The areas where the arsenic level in ground water was more than 0.050 ppm were Masjid Moth, Gulmohar Park, Raney Well (p), Lajpat Nagar, Saket and Kotla Mubarak Pur.

DISCUSSION

The hydride generation technique with subsequent atomic absorption spectrophoto-meter in suitable flame as used in present study is a well known method for determination of arsenic. Simplicity and sensitivity of both the instrument in combination, best meet the requirement for economic and fast analysis of arsenic and other hydride forming element even if they are present in trace amount in environmental media and biological fluid (29). This technique have been used in various studies reported in literature (5-7, 15, 24).

Arsenic level in 49 ground water samples collected from different areas of Delhi was in the range of 0.0170 to 0.1000 ppm, which is more than WHO recommended value for arsenic in drinking water (0.01ppm). Recent study conducted in Department of Environmental science in Guru Govind Singh Indraprastha University of Delhi has also revealed that concentration of contaminants like arsenic in

Table 1. Showing arsenic level in ground water samples of Delhi

S.No.	Source	No. of Samples	Arsenic Level (PPm)			
			Range	Mean	S.D.	SEM
1	Bawana	3	0.022-0.044	0.034	0.011	0.006
2	Masjid Moth	1	0.052	0.052	0	0
3	Gulmohar Park	1	0.064	0.064	0	0
4	Malviya Nagar	2	0.034-0.049	0.043	0.013	0.009
5	Saket	1	0.052	0.052	0	0
6	Mehrauli	3	0.040-0.049	0.044	0.005	0.003
7	Lado Sarai	1	0.042	0.042	0	0
8	S.J.Enclave	2	0.022	0.022	0	0
9	Green Park	1	0.031	0.031	0	0
10	Lajpat Nagar	1	0.057	0.057	0	0
11	K M Pur	1	0.100	0.100	0	0
12	Janakpuri	1	0.032	0.032	0	0
13	Moti Bagh	4	0.036-0.056	0.043	0.004	0.002
14	Satya Niketan	1	0.032	0.032	0	0
15	Sagarpur	1	0.036	0.036	0	0
16	RK Puram-7	2	0.050	0.050	0	0
17	RK Puram-3	1	0.050	0.050	0	0
18	RK Puram-6	3	0.042-0.050	0.047	0.005	0.003
19	Raney Well P	1	0.064	0.064	0	0
20	Raney well V	1	0.048	0.048	0	0
21	Tilak Nagar	7	0.032-0.048	0.036	0.006	0.002
22	Khyala	2	0.036-0.060	0.048	0.016	0.012
23	Raghubir Nagar	3	0.036-0.050	0.043	0.007	0.004
24	Raney Well Alipur	1	0.034	0.034	0	0
25	Raney Well 7	1	0.017	0.017	0	0
26	Okhla	1	0.044	0.044	0	0
27	East Patel Nagar	1	0.046	0.046	0	0
28	West Patel Nagar	1	0.053	0.053	0	0

Total no. of Samples = 49
Mean Value of Arsenic = 0.0431
Std. Deviation = 0.0136
Std. Error of Mean = 0.002

the ground water of Delhi exceeds the permissible limits (30).

The mechanism of presence of arsenic in ground water is not clearly known. Nickson et al suggested anoxic reduction of arseniferous iron-oxyhydroxides as the possible source of arsenic in ground water (31-32). However, this theory does not explain progressively increasing arsenic level in tube wells (33-34). According to other theory suggested by Chakraborti *et al.* on the basis of sediment analysis high volume extraction of ground water causes exposure of deltic segments to air which through oxidation reaction causes decomposition of iron pyrites. Arsenic is released in the process which then oxidised into arsenite and arsenate both of which are soluble in ground water (32-33). Le Blancs suggested catalytic oxidation of metal sulfide by stromatolytique micro organism as the possible mechanism (32).

Chakraborti *et al.* has reported elevated levels of iron in ground water samples of Bihar (20). Similarly Nag *et al.* (35) reported high concentration of iron in ground water samples in Purbasthali, Burdwan (West Bengal). These studies favour the theory of Chakraborti et al as the possible mechanism of presence of arsenic and iron in ground water of West Bengal and Bihar. Gallagher et al has mentioned that stability of As (III) and Arsenic (V) in iron rich drinking water can be affected by formation of iron precipitates (Iron Hydroxides and Oxides) (36). In Delhi, to meet the increasing public demand of water there is uncontrolled and excessive extraction of ground water. In an unofficial statement one of the Raney well used as water source was said to contain high iron level. Goswami *et al.* has reported elevated iron level in ground water of Delhi (37). Thus the presence of arsenic in ground water of Delhi can also be explained by the theory of Chakraborti et al. Further, everyday dumping of thousands of tons of garbage containing hazardous chemicals in open landfills of Delhi may be adding arsenic to the ground water (38). Chakraborti *et al.* (7) has reported the contamination of ground water due to discharge of effluent from the pesticide manufacturing industry in Calcutta. High porosity of soil causes percolation of chemicals and contamination of ground water.

In all the areas arsenic level in ground water is more than permissible limit of WHO (1993) (4). The condition may deteriorate further particularly in view of present days continuous, uncontrolled and heavy extraction of ground water and excessive use of chemicals along with discharge of hazardous waste in landfills. Therefore, extensive survey and continuous monitoring is required to be made to assess the magnitude of problem and earlier intervention.

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